REMARKS/ARGUMENTS

Claims 1-2, 5-9 and 15 are pending. By the present amendment, claim 5 is amended to correct a claim dependency.

Favorable reconsideration is respectfully requested in view of the following remarks.

REJECTIONS UNDER 35 U.S.C. § 103(a):

The Examiner first rejected claims 1, 2 and 15 under 35 U.S.C. § 103(a) as being unpatentable over GB 2 298 687 (Fenell et al.) or U.S. Patent No. 6,057,022 (Purdy et al.) in view of U.S. Patent No. 3,897,582 (Olcott) or EP 1260729 (Johnson). The Examiner stated that Fennell et al. or Purdy et al. teach all of the limitations of the claimed invention except that the core layer is a C-C composite article impregnated with refractory carbide. The Examiner goes on to state that it would have been obvious to one of ordinary skill in the art to impregnate a C-C wear layer with refractory carbide to improve the adhesion characteristics of wear layers and to provide improved heat sink capabilities for use in making friction materials.

As set forth in the applicant's response to the previous Office Action, neither Fennell et al. nor Purdy et al. disclose the subject matter of the invention of the present application.

First, Fennell et al. do not disclose a structure in which a wear layer is attached to a face portion of a core layer. Rather, the core layer and wear layer are laid-up together in a single operation (see pages 11 to 13). In addition, the central core layer in Fennell et al. is not a C-C composite impregnated with a refractory carbide.

Finally, on page 10, it is clearly stated that the invention of Fennell et al.:

> leads to a final composite structure in which the overall composite density is less in the drive regions than in the friction regions because the density of the carbon fibres is generally less than that of the deposited carbon matrix material.

This explicit teaching is clearly at odds with that of the present application, in which the wear layer (*i.e.*, the friction region) is of lower density than the core layer, as is required. In fact, all that Fennel et al. disclose is that the radial density may not be non-uniform, but the axial density (in the region of the wear face or friction surface), is uniform.

The disclosure of Purdy et al. also has several differences to the claims of the present application. Purdy et al. disclose methods of chemical vapor infiltration designed to obtain a C-C structure having varying degrees of densification within a unitary structure rather than the structure of the claims. At line 63-65 of column 8, it is stated that a symmetrical density gradient is desirable for brake disc applications. It is clear that this passage relates to the embodiment shown in FIG. 9 which incorporates a face 80 which has a higher density than the core layer. However, it will be noted that FIG. 9 does not disclose a wear layer attached to a core layer, which wear layer has a density less than the core layer, as is required.

Johnson discloses methods of forming a composite article comprising a carbon matrix containing refractory carbide particles. Such articles comprise a carbon matrix containing, within its interior, refractory carbide particles, which are substantially individually encapsulated within deposited carbon.

However, in respect to rotors for braking systems, Johnson teaches the impregnation of refractory carbide into the carbon matrix into a volume away from the periphery of the article. Hence, machining the teeth is facilitated by being performed on softer carbon matrix material rather than the harder material impregnated with refractory carbides.

Through the axial thickness of the components made in accordance with Johnson, there is, at one point, a uniform axial density. Radially, there is lower density C-C material in the region where machining takes place, and a higher density away from this region where refractory carbides have been impregnated into the structure.

Hence, the disclosure of Johnson et al. teaches away from the invention of the present application because it does not seek to provide a C-C friction surface. The 'outer' C-C layer of Johnson et al. is present for purposes of machinability, as discussed above, and, in use, said layer is not present as a finished disc as it would have been machined away.

Therefore, all Johnson et al. teach one skilled in the art is that radial density of a disc may be non-uniform to facilitate machinability in certain regions. There is no teaching of altering the axial density so as to provide a less dense wear layer.

The combination of Fennell et al. and Johnson el al. does not lead to the claimed invention because neither relates to altering the axial density, rather, both state that the axial density of a disc should be uniform. Moreover, Purdy states that for brake disc applications, the axial density should alter in a way opposite to that claimed in the present application. Johnson in no way remedies this deficiency. In fact, the combination would lead to a situation whereby the radial density was non-uniform and the wear face was of higher density than the core.

Accordingly, a combination of Fennell or Purdy with Johnson would not lead to the invention claimed in Claim 1. A similar situation arises with respect to Claim 15.

Turning now to Olcott, this document discloses at the cited passage (lines 44-66 of column 2) several advantages arising from co-depositing crystals of refractory carbides within the pyrolytic graphite crystal structure. At lines 62-66 of column 2, it is disclosed that the embedded refractory carbides of the invention give rise to improved heat sink capabilities and frictional resistance properties which make them particularly advantageous for use in making frictional braking elements. This clear teaching tells the person skilled in the art that the aciculae of crystalline SiC are aligned in the c-direction and are present in or at the wear layer of a braking element. Again, this is diametrically opposed to the invention of the present application, wherein Claim 1 requires that the core portion be impregnated with carbide particles, not the C-C wear portion.

The entire thrust of Olcott is that the provision of SiC aciculae ensures increased erosion resistance in a friction element. Indeed, Olcott does envisage varying the composition of the material through an article. However, the only example disclosed is for the outermost portion of the microcomposite to have a higher refractory carbide content to minimize surface erosion (see lines 38-43 of column 5).

This runs contrary to the claimed invention of the present application in which the outermost portion, *i.e.*, the friction faces, are of a **lower** density than the core portion of the article. Olcott does not appear to consider this possibility and provides no hint as to what benefits may be obtained by doing so. Indeed, having a lower refractory carbide content in the

outermost portion of the microcomposite would, by implication, not minimize surface erosion, which would appear to be contrary to achieving the alleged benefits resulting from the disclosure of Olcott.

Accordingly, a combination of Olcott with either Purdy or Fennell would not lead to the claimed invention in Claims 1 or 15.

Indeed, the converse would be true. Olcott simply teaches that the provision of SiC aciculae is advantageous if aligned in the c-direction because of, *inter alia*, enhanced erosion resistance.

The increased density in the wear region of Olcott confirms what is taught by Purdy, namely, that the density should be greater in the wear region.

The teaching of Olcott relates to a different problem to that of Fennell and the combination of the two does not lead to the subject matter of Claim 1 or 15.

In light of the above, it is asserted that claim 1 is allowable over the prior art of record. Since claims 2 and 15 depend from allowable claim 1, claims 2 and 15 should also be allowable. It is therefore respectfully requested that the Examiner withdraw the rejection to claims 1, 2 and 15 and pass these claims to allowance.

Moving on to the second objection, which is again one of obviousness, in respect of which the Examiner has cited a number of prior art documents.

Next, the Examiner rejected Claims 1, 2, 5-9 and 15 are rejected as being unpatentable because of obviousness over U.S. Patent No. 6,042,935 (Krenkel et al.) or U.S. Patent Publication No. 2003/0057040 (Bauer et al.) or U.S. Patent No. 6,221,475 (Domergue et al.) or

U.S. Publication No. 2002/0068164 (Martin) in view of Fennell et al. or Purdy et al. or U.S. Patent No. (Dietrich et al.) and further in view of Olcott and Johnson.

Krenkel et al. do consider a distinct core and wear face, but it proposes that SiC should be present at the wear face. Hence, this region (the wear face) would have a density equal to or higher than the core. This is the opposite situation from that disclosed in the present application.

Similarly, in Bauer et al., SiC is predominantly at the wear face. See, for example, paragraphs 0028, 0030 and 0032. Hence, the wear face region will not have a lower density than the core of the disc, as required in the Claims of the instant application.

Domergue discloses a brake disc in which C/C composites are infiltrated with SiC to provide a densified structure. The porosity of the C/C composite is arranged to allow infiltration. While the infiltration may extend throughout the disc (*i.e.*, axially), it is also envisaged that infiltration will occur just at the wear surfaces (see column 9 at lines 15 to 34). Clearly, the teaching of Domergue in relation to disc density is two-fold, either the disc is to have uniform axial density (infiltration throughout the disc), or it is to have non-uniform axial density, but the density is to be <u>higher</u> at the wear faces.

As will be appreciated, this is in contradiction with the requirements of Claims 1, 6 and 15 of the present application.

Martin does not disclose a brake disc for an aircraft, but one for a motor vehicle, such as a car. In any case, in Martin, SiC is present throughout the material including the wear region, as is discussed at paragraph 0021 thereof. As will be appreciated, in all cases, the disc is infiltrated with silicon after formation. In which case, the silicon will infiltrate from the friction face

forward the core region. This will result in the core either having the same or lower density than the friction faces.

The respective shortcomings of Fennell et al. and Purdy et al. in relation to the claimed invention of the present application are discussed above, as are the disclosures of Olcott and Johnson.

Dietrich discloses a disc and pad friction couple with the pad friction surface being a lower density than the disc. This is not the same as a brake disc for an aircraft or an aircraft brake disc. The person skilled in the motor vehicle brake arts understands that the configuration of Dietrich is normally done to cause the pad to wear in preference to the disc for maintenance purposes. In any case, there is no disclosure of a disc having a wear portion which is of lower density than a core portion to which it is attached. Indeed, the discs of Dietrich have uniform axial density.

Krenkel et al., Bauer et al. and Domergue all disclose SiC at the wear face. Hence, they do not disclose a wear layer having a density lower than the core layer. Likewise, Fennel et al. and Purdy et al. do not provide discs in which the density is lower at the wear face than the core.

Olcott also discloses that SiC impregnated materials should be used in the friction layer of an aircraft braking system.

Furthermore, Dietrich and Johnson disclose unitary bodies produced in a single operation. This is distinct from Claim 1 of the present application which requires a wear layer to be attached to a face portion of a core layer. In other words, two separately formed components

are attached together. Consequently, in use, when the wear layer becomes too worn, it can be replaced with a new one, without having to replace the core layer as well.

Hence, as the feature of a wear layer attached to a face portion of a core layer with the wear layer having a density lower than the core layer as required by Claim 1 of the present application is absent from each and every one of the cited prior art documents, there can be no possible combination which would provide an article having all of the features required by Claim 1 of the present application.

A similar objection to the Examiner's assertion is propounded with respect to Claims 6 and 15.

Therefore, it is submitted that Claim 1 is not obvious and should be allowed. Since Claims 2 and 5 depend from claim 1, these claims should also be allowed.

The above discussion applies in equal effect to Claims 6 and 15 which are similarly allowable.

The Examiner asserts that in light of the cited prior art, it would have been obvious to one of ordinary skill in the art at the time the invention was made to impregnate a C-C wear layer with refractory carbide. This may be so, but the objection misses the point insofar as the invention claimed in the present application requires that the core component, not the wear component, is impregnated with refractory carbide.

Therefore, it is asserted that the rejection of Claims 1, 2, 5-9 and 15 should be withdrawn and these claims should be passed to allowance.

For at least the reasons set forth above, it is respectfully submitted that all of the rejections have been overcome and the above-identified application, as amended, is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1, 2, 5-9 and 15 are respectfully requested.

Should the Examiner believe that anything further is desirable in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned attorney at the telephone number listed below.

Respectfully submitted,

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